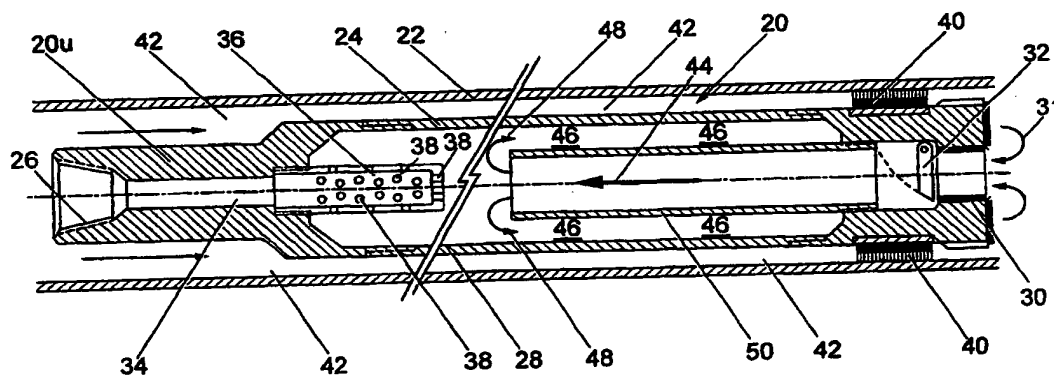




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<p>(21) International Application Number: PCT/GB99/02666</p> <p>(22) International Filing Date: 26 August 1999 (26.08.99)</p> <p>(30) Priority Data: 9818506.9 26 August 1998 (26.08.98) GB</p> <p>(71)(72) Applicants and Inventors: DOIG, Thomas [GB/GB]; 32 Earlsweils Road, Cults, Aberdeen AB15 9NY (GB). NICOLI, George [GB/GB]; High Pines, 46 Culter House Road, Milltimber, Aberdeen (GB).</p> <p>(74) Agent: MURGITROYD & COMPANY; 373 Scotland Street, Glasgow G5 8QA (GB).</p>		<p>(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).</p> <p>Published With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</p>

(54) Title: A REVERSE CIRCULATING TOOL FOR CLEANING A WELL



(57) Abstract

A tool and method for circulating fluid within a borehole wherein fluid is passed down an annulus between the tool and the borehole, the fluid being returned to the surface through the tool whereby it may be recycled. The tool typically includes a cavity in which particles of dirt, drill cuttings or the like are collected. The tool may also include a filter to prevent larger particles of dirt etc. from continuing upward to the surface. The tool may also include a trap to prevent particles of dirt etc. from returning into the borehole from the tool.

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A REVERSE CIRCULATING TOOL FOR CLEANING A WELL

1
2
3 The present invention relates to a tool particularly,
4 but not exclusively, for circulating fluids in
5 wellbores. The tool can also be used for circulating
6 fluids in other bores such as pipes.
7
8 When oil or gas drilling operations have been completed
9 and the wellbore has been lined, the bore is cleaned to
10 remove dirt, drill cuttings or the like which
11 accumulate during drilling and lining operations.
12 Cleaning takes place before production commences, as
13 the cuttings from these operations may contaminate any
14 hydrocarbons recovered from the well.
15
16 Conventionally, a circulating tool is attached to a
17 length of drill pipe and then inserted into the well.
18 Fluid is then pumped down the drill pipe and into the
19 well through the circulating tool. The fluid then
20 flows upwards in the annulus between the wall of the
21 borehole (or the casing of the well) and the tubing
22 string, washing the cuttings and the like upwards.
23
24 The lengths of drill pipe from which the circulating
25 tool is suspended may range from a typical inside

1 diameter (ID) of 5 inches (127mm)⁵ nearer the top of the
2 bore, to 3½ inches (89mm) lower down. The maximum flow
3 rate through the drill pipe (and thus the circulating
4 tool) will be restricted by the ID of the drill pipe
5 lower down.

6
7 The casing is generally made up of lengths of liner
8 which are cemented (or otherwise attached) to a
9 wellbore 10, as shown in Fig. 1. The ID of each
10 section is generally larger than the next section lower
11 down the well. For example, a casing section 12 nearer
12 the top of the bore 10 may have an ID typically in the
13 order of 8½ inches (215mm). The casing section lower
14 down the well may have an ID typically of the order of
15 7 inches (178mm).

16
17 Steps or ledges 16 are created in the casing by the
18 reduction in ID of the adjacent casing sections.
19 Particles of dirt, cement, drill cuttings and the like
20 may collect on these steps 16. These particles are
21 difficult to remove from the steps 16 as they are
22 outwith the normal fluid path.

23
24 In accordance with a first aspect of the present
25 invention, there is provided a tool for circulating
26 fluids in a borehole, the tool comprising a body for
27 insertion into a borehole and to define an annulus
28 between the body and the borehole, the body having a
29 conduit with an inlet for passage of fluids
30 therethrough, whereby fluid passed through the annulus
31 can pass subsequently through the conduit.

32
33 The tool can optionally have an annular cavity for
34 collection of particles, located between the conduit
35 and a sleeve connected to a lower section of the
36 conduit and terminating within or continuous with the

1 conduit, so as to allow fluid flow between the cavity
2 and the conduit.

3
4 The body is preferably provided with a sump. A sleeve
5 is typically located in a lower part of the conduit to
6 form an annular sump between the sleeve and the
7 conduit. Particles of dirt etc preferably collect in
8 the sump.

9
10 A filter is typically located in the conduit and
11 typically comprises a baffle. The baffle typically has
12 a plurality of apertures. The apertures are typically
13 of the order of $\frac{1}{8}$ inch (approximately 3mm) in diameter.
14 The filter is preferably located in an upper portion of
15 the conduit, and prevents upward passage of cuttings.

16
17 The conduit may be provided with a valve to retain
18 cuttings but to allow fluid passage. The valve may
19 comprise an array of spring-loaded fingers arranged at
20 the inlet, allowing passage of fluid and cuttings into
21 the conduit, but retaining the cuttings or debris which
22 would otherwise fall back into the well.

23
24 The body is typically provided with pipe cleaning
25 means. The pipe cleaning means is typically in the
26 form of brushes attached to the exterior of the body.

27
28 The fluid is typically brine. Any conventional fluid
29 such as drilling mud or the like may be used.

30
31 In accordance with a second aspect of the present
32 invention, there is provided a method of circulating
33 fluid in a borehole, the method comprising the steps of
34 inserting into the borehole a conduit member having a
35 conduit therethrough so that an annulus is formed
36 between the conduit member and the borehole, passing

1 fluid through the annulus, and subsequently passing
2 fluid through the conduit.

3
4 The conduit is preferably a tubular or string of
5 tubulars such as a drill string. The fluid is
6 preferably first pumped down a relatively high volume
7 annulus and then up through the relatively narrower
8 conduit in order to allow a higher volume of fluid to
9 be pumped into the well initially, and at higher flow
10 rates upon passage through the conduit. The higher
11 flow rates on the upward passage increase the
12 turbulence in the flow when entering the relatively
13 narrow tubular and assist in the washing action at the
14 bottom of the tubular where cleaning is mainly
15 required.

16
17 The annulus between the conduit and the borehole is
18 preferably sealed above the fluid injection point so as
19 to allow pressurised injection.

20
21 The borehole may be cased.

22
23 The conduit may comprise a sump for collection of
24 cuttings and the like, and optionally a filter to
25 divert cuttings into the sump and prevent continuing
26 upwards passage of the cuttings through the conduit.

27
28 Fluid may also be passed from the conduit down into the
29 well and returned through the annulus between the
30 conduit and the borehole.

31
32 The method typically includes the step of circulating
33 fluid down the conduit whilst the conduit is being run-
34 in.

35
36 Embodiments of the present invention will now be

1 described, by way of example only, with reference to
2 the accompanying drawings in which :-

3
4 Fig. 1 is a sectional elevation of an exemplary
5 borehole which has been lined with casing; and
6 Fig. 2 is a sectional view of a downhole tool in
7 accordance with a first aspect of the present
8 invention.

9
10 With reference to Fig. 2 there is shown a downhole tool
11 20 for circulating fluids in a borehole 22, the tool 20
12 including a body 24 which is provided with means for
13 attachment to a drill string, which in this example is
14 a female box connection 26 provided at an upper end 20u
15 of the tool 20.

16
17 The body 24 has a central bore, which includes a
18 chamber 28. The bore comprises a lower section 30
19 having an inlet 31 which is in communication with the
20 chamber 28 through a flapper-type float 32. As an
21 alternative to the flapper-type float 32, a plurality
22 of spring-loaded fingers may be used. Use of the
23 fingers is preferred, as this allows the tool 20 to
24 circulate fluid in both directions.

25
26 The chamber 28 is also in fluid communication with an
27 upper section 34 of the bore through a baffle 36. The
28 baffle 36 has a plurality of apertures 38, which are
29 typically of the order of $\frac{1}{8}$ inch (approx. 3mm) in
30 diameter, although any size of aperture 38 may be used.

31
32 The tool 20 may also be provided with external brush
33 attachments 40. The brush attachments 40 contact the
34 internal surfaces of the casing liner to loosen
35 cuttings etc on the liner or on ledges 16 (Fig. 1).

36

1 In use, the tool 20 is attached to a lower end of a
2 tubing string and run into the wellbore 22. As the
3 tool 20 is being run-in, fluid can be pumped down the
4 bore of the tool 20 to clean the wellbore 22 ahead of
5 it.

6
7 Once the tool 20 has reached the lower end of the
8 wellbore 22 (and is preferably close to the bottom of
9 the well), an annular preventer or blow-out preventer
10 (BOP) is closed to seal the annulus 42 around the
11 tubing string and tool 20. Fluid is then pumped into
12 an annulus 42 between the tubing string and the
13 wellbore 22 at an injection point just below the BOP.
14 The fluid used is typically brine as its consistency is
15 not as thick as other downhole fluids, such as drilling
16 mud. Thus, brine can collect dirt and cuttings etc but
17 is not thick enough to solidify and thus block the
18 smaller diameter drill pipe used in the string above
19 the tool 20. The fluid can also be a brine-based fluid
20 which is thicker than brine but still fluid enough to
21 The fluid passes down the annulus 42, collecting
22 particles of dirt and cuttings which are located within
23 the annulus 42. In particular, the fluid will collect
24 any cuttings etc on the ledges 16 created by the liners
25 12 (Fig. 1), aided by the brush attachments 40 as
26 described.

27
28 Fluid then enters the tool 20 through the inlet 31 at
29 the lower section 30 of the bore. As it passes upward
30 through the lower section 30, the fluid passes through
31 the flapper-type float 32 (or spring-loaded fingers).
32 Although this embodiment shows a flapper-type float 32,
33 it is preferable to use a plurality of spring-loaded
34 fingers. The fingers allow for bi-directional movement
35 of fluids through the tool 20.

36

1 It should be noted that the function of the flapper-
2 type float 32 (or the fingers) is to prevent any dirt
3 etc which enters the tool 20 from re-entering the
4 annulus 42 during use of the tool 20.

5
6 The annulus 42 is a relatively large volume when
7 compared to the smaller volume of the inlet 31. Thus,
8 when fluid goes from the higher volume of the annulus
9 42 to the smaller volume of the inlet 31, a turbulence
10 is created at the inlet 31 due to the increase in flow
11 rate through the tool 20. This turbulence facilitates
12 improved cleaning of the annulus 42 at, or near, the
13 inlet 31.

14
15 The fluid (including any particles of dirt) continues
16 up into the tool 20 as indicated by arrow 44, through a
17 sleeve 50. An annular cavity 46 between the sleeve 50
18 and the chamber 18 collects particles of dirt and
19 cuttings etc. As the fluid exits the sleeve 50, the
20 cuttings etc fall into the cavity 46, as indicated by
21 arrows 48. Thus, substantially all of the larger
22 particles of dirt, drill cuttings etc collect in the
23 cavity 46. More than one cavity can be provided in a
24 stack or segment arrangement.

25
26 The fluid continues in an upward direction and contacts
27 the knock-out baffle 36, having apertures 38. The
28 apertures 38 are of the order of $\frac{1}{8}$ inch (approximately
29 3mm) in diameter. Thus, the larger particles of dirt
30 etc are prevented from entering the drill string above
31 the tool 20. The risk of dirt etc blocking the
32 relatively smaller diameter drill pipe above the tool
33 is therefore reduced. The larger particles collect in
34 the cavity 46 as described.

35
36 The fluid then exits the tool 20 through the upper

1 section 34 of the bore and continues to the surface
2 through the drill string where it may be recycled.

3
4 As the particles collect in cavity 46, the tool 20
5 begins to fill-up. This can be measured at the surface
6 as a pressure increase and it is preferable to remove
7 the tool 20 from the well to clean out the cavity 46
8 before continuing the cleaning operation. It should be
9 noted that as the tool 20 is being retracted, the
10 particles are held within the cavity 46 and prevented
11 from re-entering the annulus 42 by the float 32 or
12 fingers. The size of the cavity 46 can be modified to
13 accept a larger volume of cuttings etc.

14
15 The tool 20 works on volumetric displacement. If 1
16 gallon of fluid is pumped in, 1 gallon of fluid is
17 retrieved at the surface.
18
19 Thus, there is provided a downhole tool which can
20 facilitate bi-directional circulation of fluids. As
21 the tool is being run-in, fluid is pumped ahead of it
22 to clean the well. Once in position, the direction of
23 fluid travel is reversed. The tool is optionally
24 provided with two filtration mechanisms; the first
25 prevents the particles of dirt etc which enter the tool
26 from re-entering the well, and the second substantially
27 prevents dirt etc from blocking the drill string above
28 the tool.

29
30 The tool may also be provided with external means, such
31 as brushes, for cleaning the surface of the casing or
32 liner as the tool is run-in or retracted.

33
34 Modifications and improvements may be made to the
35 foregoing without departing from the scope of the
36 present invention.

1 CLAIMS

- 2
- 3 1. A tool for circulating fluids in a borehole, the
- 4 tool comprising a body for insertion into a
- 5 borehole and to define an annulus between the body
- 6 and the borehole, the body having a conduit with
- 7 an inlet for passage of fluids therethrough,
- 8 whereby fluid passed through the annulus can pass
- 9 subsequently through the conduit.
- 10
- 11 2. A tool according to claim 1, wherein the body
- 12 includes a cavity for collection of particles.
- 13
- 14 3. A tool according to claim 2, wherein the cavity is
- 15 annular.
- 16
- 17 4. A tool according to claim 2 or claim 3, wherein
- 18 the cavity is formed in a lower section of the
- 19 conduit.
- 20
- 21 5. A tool according to any one of claims 2 to 4,
- 22 having more than one cavity.
- 23
- 24 6. A tool according to claim 5, wherein cavities are
- 25 disposed beside one another.
- 26
- 27 7. A tool according to claim 5, wherein the cavities
- 28 are spaced longitudinally along the tool.
- 29
- 30 8. A tool according to any preceding claim, wherein a
- 31 filter is located in the conduit.
- 32
- 33 9. A tool according to claim 8, wherein the filter
- 34 comprises a baffle.
- 35
- 36 10. A tool according to claim 9, wherein the baffle

1 has a plurality of apertures.

2

3 11. A tool according to any one of claims 8 to 10,
4 wherein the filter is located in an upper portion
5 of the conduit, and prevents upward passage of
6 cuttings.

7

8 12. A tool according to any preceding claim, wherein
9 the conduit is provided with a trap to retain
10 dirt, drill cuttings or the like in the body of
11 the tool whilst allowing fluid passage.

12

13 13. A tool according to claim 12, wherein the trap
14 comprises an array of spring-loaded fingers
15 arranged at the inlet, allowing passage of fluid
16 and cuttings or the like into the conduit whilst
17 retaining the cuttings within the tool.

18

19 14. A tool according to any preceding claim, wherein
20 the body is provided with cleaning elements on its
21 outer surface.

22

23 15. A tool according to claim 14, wherein the cleaning
24 elements comprise brushes.

25

26 16. A tool according to any preceding claim, attached
27 to a tubing string, drill string or the like.

28

29 17. A method of circulating fluid in a borehole, the
30 method comprising the steps of inserting into the
31 borehole a conduit member having a conduit
32 therethrough so that an annulus is formed between
33 the conduit member and the borehole, passing fluid
34 through the annulus, and subsequently passing
35 fluid through the conduit.

36

- 1 18. A method according to claim 17, wherein the
2 conduit member comprises a tubular or string of
3 tubulars.
4
- 5 19. A method according to claim 17 or claim 18,
6 wherein the conduit member comprises a drill
7 string.
8
- 9 20. A method according to claim 18 or claim 19,
10 wherein the fluid is first pumped down the annulus
11 and then up through the conduit.
12
- 13 21. A method according to any one of claims 17 to 20,
14 wherein the annulus has a larger volume than the
15 conduit.
16
- 17 22. A method according to any one of claims 17 to 21,
18 wherein the annulus is sealed above the fluid
19 injection point so as to allow pressurised
20 injection.
21
- 22 23. A method according to any one of claims 18 to 22,
23 wherein the conduit member includes a cavity for
24 collection of cuttings and the like.
25
- 26 24. A method according to claim 23, wherein the
27 conduit member includes a baffle to divert
28 cuttings into the cavity and prevent continuing
29 upward passage of the cuttings through the
30 conduit.
31
- 32 25. A method according to any one of claims 17 to 24,
33 wherein fluid is alternately passed from the
34 conduit into the annulus and from the annulus into
35 the conduit.
36

- 1 26. A method according to any one of claims 17 to 25,
2 the method including the step of circulating fluid
3 from the conduit member whilst the conduit member
4 is being run into the borehole.
5
6 27. A method according to any one of claims 17 to 26,
7 wherein the fluid is brine.
8
9

1 / 2

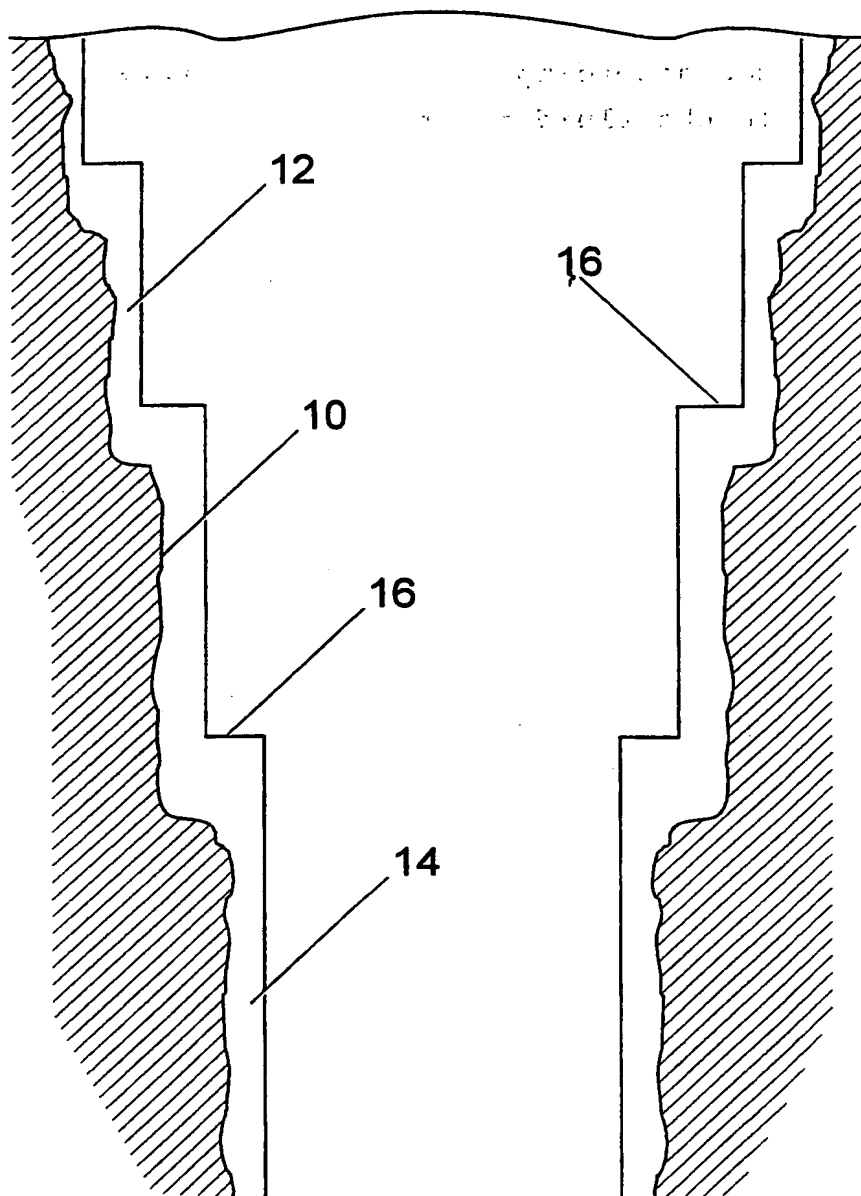


Fig. 1

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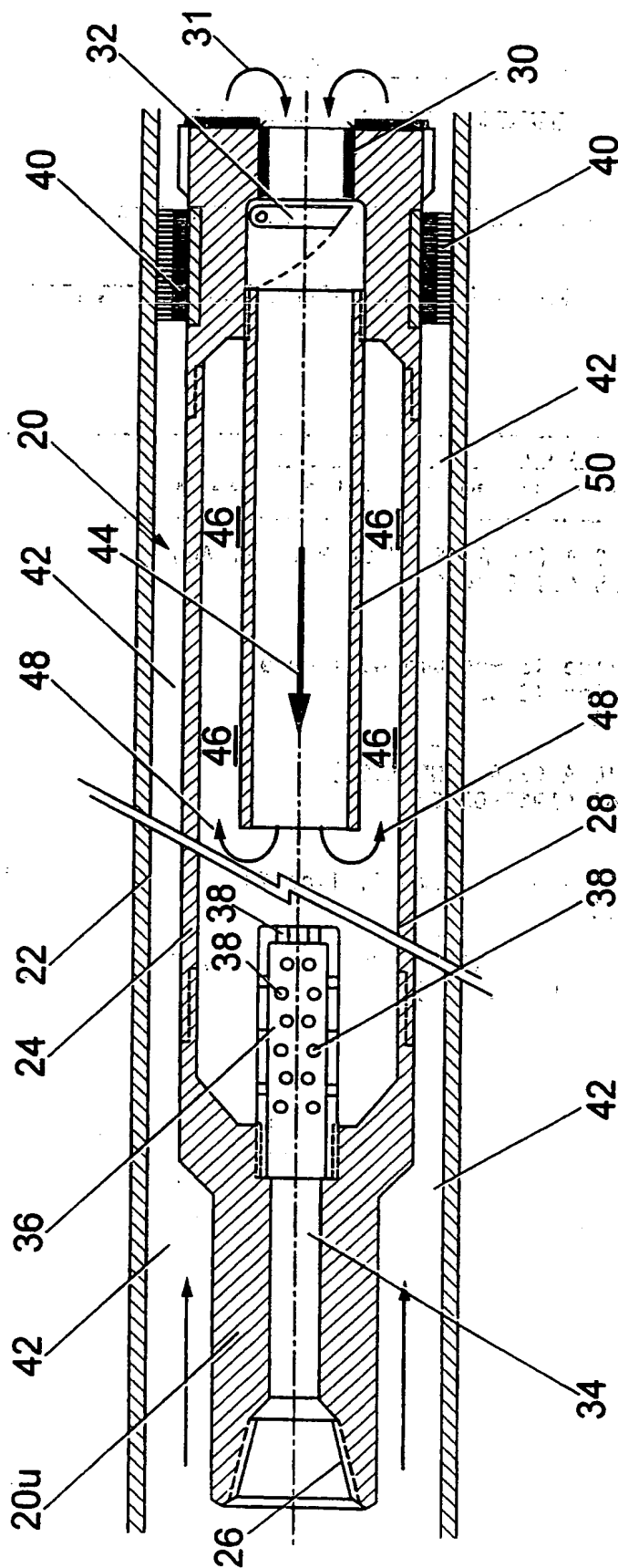


Fig. 2

INTERNATIONAL SEARCH REPORT

International Application No.

PCT/GB 99/02666

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 E21B37/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	US 5 318 128 A (JOHNSON MICHAEL H ET AL) 7 June 1994 (1994-06-07) abstract; figure 1	1, 16-20, 27

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

20 December 1999

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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